NRI research highlights

NATIONAL RESEARCH INITIATIVE COMPETITIVE GRANTS PROGRAM

United States Department of Agriculture

Cooperative State Research, Education, and Extension Service

March 1998

Mapping Food Temperature With Magnetic Resonance Imaging

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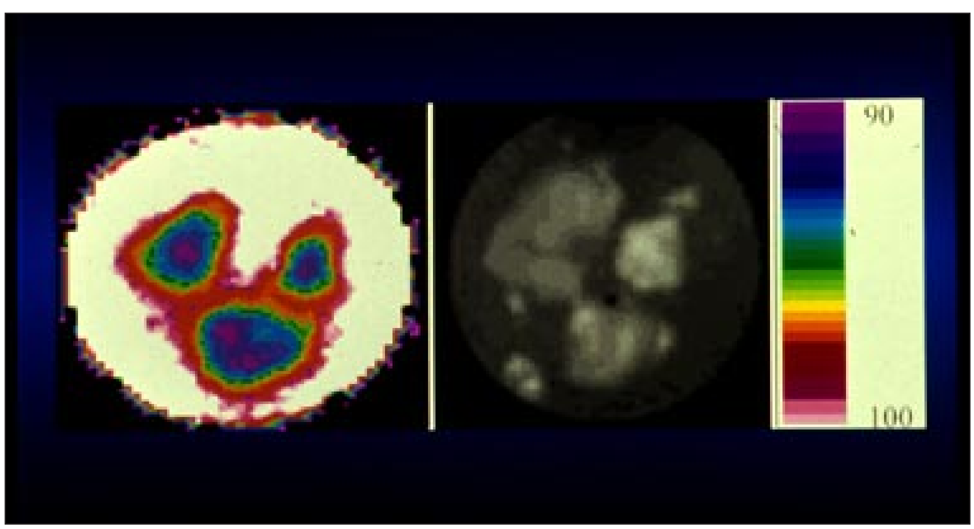
A busy parent pops a container of juice into the children's lunch boxes. A young camper enjoys commercially sterilized milk on his breakfast cereal. A harried homemaker gets a container of pudding from the cupboard for a quick snack after work. These consumers are enjoying the benefits of *aseptic processing*—the commercial sterilization and packaging of food in sterile containers.

Aseptic processing provides many advantages over canning, freezing, and other traditional preservation methods. Liquids and paste-type foods such as juices and puddings are packaged in lightweight, easily portable containers and can be stored before opening without refrigeration. Thanks to modern methods of heat transfer and temperature control, aseptically processed foods often taste better and are more nutritious than foods processed using more traditional methods.

One of the major food-processing challenges of the decade has been to find a way to extend the benefits of aseptic processing from liquids to additional types of foods, especially to particulate-containing items such as chunky soups, stews, purees, and cut fruits and vegetables packed in liquids. To accomplish this, food processors have needed a method of measuring the temperature of each food particle to ensure that it has been heated sufficiently to kill harmful microorganisms—while allowing the food to flow continuously through the processing system.



A COLOR TEMPERATURE MAP OF POTATO PARTICLES. THE BLACK-AND-WHITE IMAGE SHOWS THE LOCATION OF PARTICLES IN THE HOLDING TUBE. THE COLOR KEY REPRESENTS DEGREES CENTIGRADE.

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MRI techniques can lead to improved food manufacturing processes and a wider range of food products.

Scientists at the University of Illinois have helped solve this problem by developing a new, noninvasive way to measure food temperature: magnetic resonance imaging (MRI). With support from USDA's National Research Initiative (NRI) Competitive Grants Program, the scientists have adapted medical equipment to map temperature changes in food particles as a food sample is heated. Here's how it works: Researchers place a food sample inside a magnetic field, where energy is used to stimulate the protons inside the food. When the energy source is turned off, the protons return to their relaxed position, producing an image of the food material.

The MRI image is then transformed into a temperature map (see illustration, reverse page). In the map, variations in color represent variations in temperature, allowing researchers to determine whether the entire food sample has received sufficient heat treatment.

MRI techniques have many advantages over other temperature-mapping methods tested so far. Using MRI, researchers can obtain two- or three-dimensional images as well as accurate measurements undistorted by textural differences in food composition. In addition, the measurements can be made quickly: An accurate 64- by 64-pixel two-dimensional image can be obtained in approximately 8 seconds.

The researchers are working in partnership with Tetra Pak, a manufacturer of aseptic processing equipment, to refine MRI temperature-mapping techniques using potato soup. The techniques currently are being applied to food in an aseptic holding tube inside a processing line (see illustration below). Ultimately, the scientists hope to devise an on-line MRI system that profiles both temperature and flow velocity during food processing.

In May 1997, the Food and Drug Administration accepted a process filing from Tetra Pak for an aseptically processed and packaged potato soup product. MRI data obtained from a similar Tetra Pak system used in the Illinois project were helpful in understanding the adequacy of the process.

Research in magnetic resonance imaging holds promise for additional areas of food processing technology as well. MRI data can yield information about a number of important food properties, including food stability and maturation, water mobility, flow behavior, and mass and heat transfer. As a result, MRI techniques can lead to improved food manufacturing processes and a wider range of food products for consumers. ❖

RESEARCHER CARLOS KANTT ADJUSTS THE PROCESSING LINE PASSING THROUGH THE MAGNET BORE IN THE MRI INSTRUMENT.

The research reported in this factsheet was sponsored by the Enhancing Value and Use of Agricultural and Forest Products Division of the NRI and the University of Illinois at Urbana-Champaign in collaboration with Tetra Pak. To be placed on the mailing list for this publication or to receive additional information, please contact the NRI (202/401-5022 or NRICGP@reeusda.gov). The factsheet also is accessible via the NRI section of the Cooperative State Research, Education, and Extension Service web site at http://www.reeusda.gov/nri